E/CONF.39/A/46
1 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A.3.4.2

Israel

DEMINERALIZATION OF SEA WATER FOR PRACTICAL APPLICATIONS

By J. ADARI,
Managing Director,
Desalination Plants, Ltd.

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DEMINERALIZATION OF SEA WATER

FOR

PRACTICAL APPLICATIONS

By J. ADARI,
Managing Director,
DESALINATION PLANTS LTD.

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Water, many will readily agree, is the key to the economic development of vast areas in many parts of the world. The geographical distribution of fresh water sources is uneven and does not always correspond to requirements. The only source of water that is practically unlimited is the sea. The conversion of sea water into fresh water, however, is often raising objections which derive their momentum from unfavourable cost factors. Let us therefore start our discussion with a brief analysis of natural and desalted water cost factors.

1. COST FACTORS OF NATURAL WATER SUPPLY

Water supply facilities must always be designed to meet increasing demand for agricultural, industrial and domestic uses. The growth of the national economy together with the improvements in the standards of living are coupled with swift increases in the demand for water. Supply facilities, therefore, must be planned with considerable excess capacity, which calls for large capital investments.

This problem is universal. Water projects must always be planned with excess capacity, leaving the unutilized capital idle for long periods. It is true, of course, that the idle capital could easily be written off with the rest of the investment by charging it against water actually supplied. Such a method of calculation tends to increase the price of water significantly. The economic cost of idle capital, however, is much higher than dollars and cents of expenditure would indicate. Idle capital could be brought to productive use and it is the benefits of such productivity that must be charged against the cost of water. The greater the marginal efficiency of capital the higher the cost of idle capacity in water installations.

When we measure the total capital investment against the quantity of water produced over a certain period we may find that unless depreciation charges are stretched over many decades the cost is high. By allowing capital expenses to be repaid over a long period we admit economic forces that tend to cut deeply into the ratio of water charges to the real value of the investment. Inflation and rising prices tend to multiply the amount of capital required to rebuild existing facilities while the depreciation charges are usually compiled on the basis of historical costs. If a larger part of the investment is to be retired in real terms costs components representing capital outlays will have to be changed considerably with a significant increase in the price of water.

Ambitious water projects take many years to complete, they may demand a large number of employees and require large amounts of capital. In short, considerable economic resources must be mobilized with their benefits many years away. Such a drain on economic resources may have significant long-run effects on the national economy and must be evaluated accordingly.

An analysis of natural water costs will reveal two things:

(a) There is a built-in tendency of water supply costs to increase.

(b) There is a large and increasing discrepancy between prevailing and real economic costs of water supply.

The result - increasing hidden national subsidies to the cost of water.

2. COST ELEMENTS OF DESALTED WATER

The main cost elements of demineralized water are very much the same as those of natural water. Capital charges, power and wages comprise the most important cost components of such water. There are, however, three important considerations that tend to distinguish between the cost structure of demineralized water as compared with natural water.

(a) The payback period of the investment is relatively short and the chances of getting back in interest and depreciation the real value of the invested capital are much better in saline water conversion installations than in large natural water supply projects.

Technological improvements, too, may cut deeply into the anticipated economy of long-range projects. The same is true for geographical changes in the distribution of national production facilities. All these considerations put a heavy toll on long-range projects. By restoring to projects of a shorter retirement age, savings are realized that may offset the additional expenses involved.

(b) Increasing the supply of desalinated water to meet a growing demand tends to decrease the cost of water without adversely affecting the sources of supply.

The ever-increasing demand for saline water conversion equipment and the keen interest among manufacturers in various demineralization processes have already pushed desalination costs considerably downward. The costs of converting sea water were reduced from over $5.- per 1,000 gallons to about $1.- in one decade. The intensity and variety of research and development programs recently undertaken give every indication of further improvements. Consequently, many parts of the world face a situation in which ever-increasing costs of natural water rise to meet the decreasing costs of converted sea water. Finding the points at which these two costs equal each other should be an important objective of every nation concerned with water problems.

(c) Saline water conversion installations hardly affect general economic conditions. Their size and structure leave little difference between such plants and automated industrial establishments of similar dimensions. Moreover, since conversion equipment does not necessarily have to be built at the location of the installation, the impact of large capital investments on the economy can easily be adjusted to suit local conditions.

To the general evaluation of cost trends affecting natural and demineralized water, a number of considerations must be added that have a specific bearing on less developed areas.

Water supply systems in modern countries were developed over many years, sometimes spreading the cost of such installations over several generations. Such a gradual development of water installations required a method of costing that less developed countries can hardly reckon with. Suppose location A is situated 1,000 miles from the closest source of natural water but a pipeline previously installed brings water in large quantities to location B, 50 miles away from A. The cost of supplying water to location A would be equal to the cost of transporting the water over 50 miles rather than 1,000 miles. This kind of marginal costing can be applied only in areas where existing water facilities are extensive enough and independent enough to make it possible. Newly-developed areas are usually less fortunate. In such places the full cost of water must be applied, and this tends to increase considerably the price of water to consumers.

In newly-developed areas the development of adequate water supply systems is usually integrated into a general plan of economic development. As such the water supply system must be geared to the patterns of economic development in each area. It would not be sensible to develop a water system suitable for an intensive agricultural economy if the area involved is planned for industrialization and urban development. Many manufacturing industries and urban communities can develop on water supplied at prices that would push farm products' costs to uncompetitively high levels. It is unnecessary to make high capital investments that would result in very low water unit costs when smaller investments resulting in higher unit costs would be adequate. The capital saved could effectively be utilized for other purposes yielding higher interest rates carrying larger depreciation charges.

Lack of capital is usually one of the most important factors limiting the pace of economic growth in less-developed areas. A careful evaluation of the real water requirements in each area with special consideration of the permitted water prices can help save and generate large amounts of capital that would otherwise be invested in ambitious uneconomical water projects aiming at unrealistically low prices. Such an evaluation will often point at the economy of local, small-scale solutions with short retirement age rather than nation-wide extensive long-range projects. Among such solutions the demineralization of saline water will play an ever-increasing role.

Conversion installations for sea and brackish water are operating in many areas. Detailed literature is available describing the various processes and techniques and little can be added here.

A relatively new approach was adopted in the development of the freezing process. The idea is to design and build a complete self-contained unit in the factory, capable of operating at a certain capacity. A conversion plant will consist of one or several such units linked together in a battery. The advantages foreseen in this approach are:

(a) The module is engineered once and can be used for plants of different size with no additional engineering.

(b) The module serving various-sized plants can be produced in large series thus reducing the production cost considerably.

(c) The erection of a plant consisting of self-contained and complete units is simple and demands minimum time. The workers doing the erection job on site do not have to be highly skilled.

(d) By having several modules in one plant stand-by units are not necessary. Maintenance time is cut and can be extended over a longer period on a rotational basis.

(e) The investment in the plant is proportional to needs and the whole invested capital is utilized in full from the very beginning. The plant can be increased with time according to growing needs and no big reserves are needed.

(f) Desalination equipment is undergoing development and modifications continually and the cost of the equipment is decreasing while efficiency is increased. The ability to aid units to an existing plant enables the user to increase production by adding more developed units and thus reducing the water cost without having to leave a complete plant in abeyance.

(g) Areas where moderate plants are suitable in many cases lack refrigeration facilities and ice supply. A combination of a freezing conversion plant to produce fresh water and ice is of advantage and may reduce water cost.

It is beyond the scope of this article to enter into detailed calculations of investment and water cost for various combinations of plants according to this approach. A fair idea of equipment cost, power requirement and manpower for operation is given in the following chart.

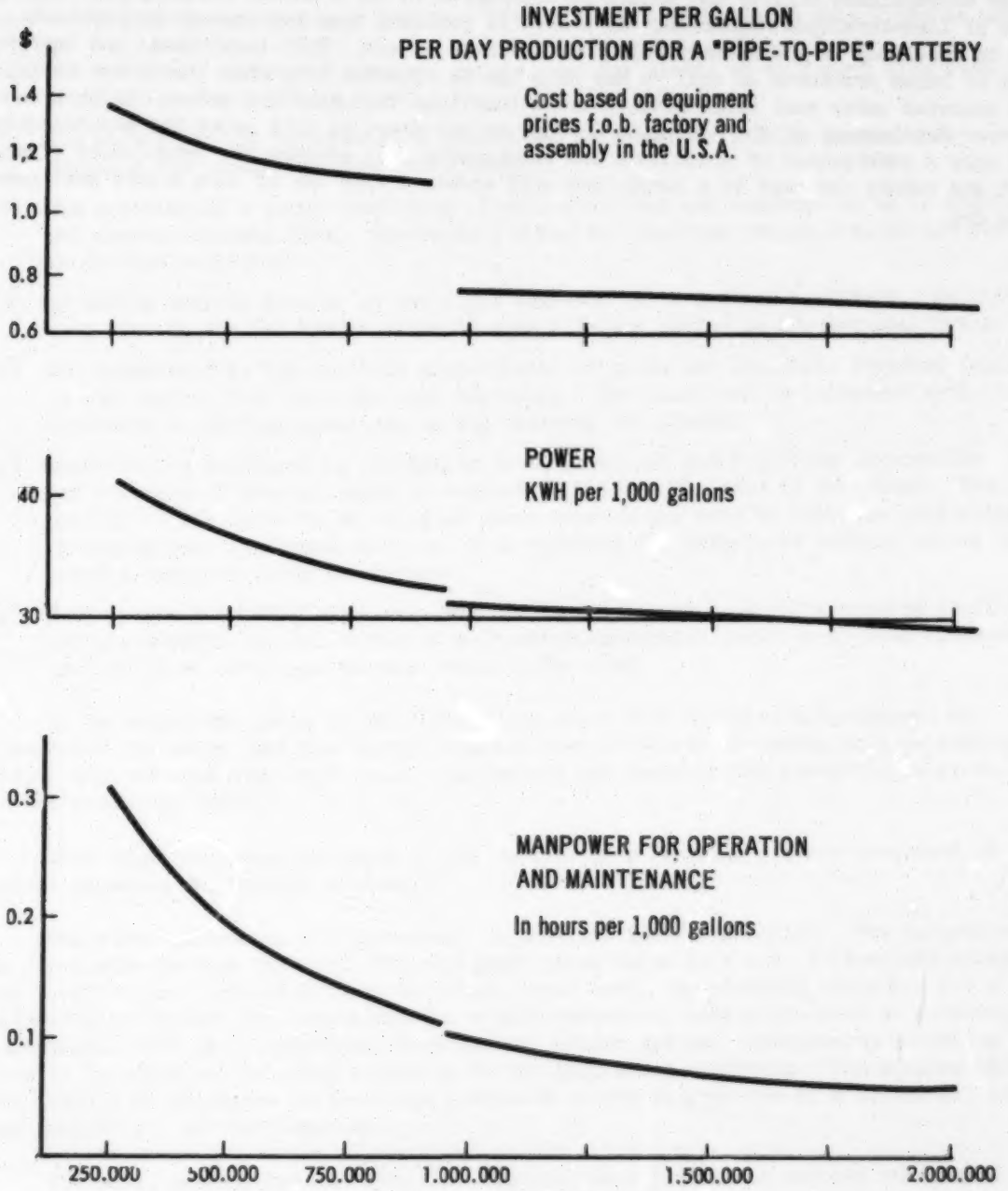
This chart was computed based on the results of a freezing process developed in Israel known as the Zarchin process.

The curve indicating the investment is in $ per installed gallon. The investment is for a pipe-to-pipe battery. The equipment price taken is f.o.b. factory and assembly and erection are calculated based on U.S.A. labor cost. By plotting the curve for a pipe-to-pipe battery the investment for a self-contained conversion unit is attained independent from site conditions, location and intake system. Investments depending on site location can be added according to the individual condition. The modules used for investment estimates in the range indicated in the diagram are of a 60,000 gl. per day and 240,000 gl. per day capacity.

The power consumption and operation expenses were plotted in kwH and man-hours per 1,000 gl. so that local costs and wages can be applied.

The curves indicate the conditions today. Research and development are continued and improvements are anticipated. A demonstration plant is being built in Eilat on the gulf of Akaba based on the Zarchin freezing process and on the module approach described.

There are different processes and different approaches to solving the problem of conversion of sea water into fresh useable water. This field is so wide and important that it arouses the imagination and curiosity of many interested scientists. At the state of art today there is no process or approach that can claim full superiority. Development work continues and increases. One fact is unquestionable. The conversion of sea water is an accomplished reality and should be considered in the economic planning and development of less-developed countries. It should be realized that any process or approach can be developed in the factory only to a definite extent. Full development and improvement of known processes as well as new ones can be achieved only when plants are installed and operated under real field conditions in locations that need the water. In this sense further development of the equipment depends on the users as well as on the manufacturers and only a combination of production and utilization will advance the improvement of equipment and reduce the cost to a level that will enable a wide use of this source that never runs dry.



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